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LEVEL

DELAWARE RIVER BASIN
HORNBECKS CREEKS, PIKE COUNTY
PENNSYLVANIA
NDI NO. PA.01107
DER NO. 52-103

(P)

LOWER RICKARDS DAM

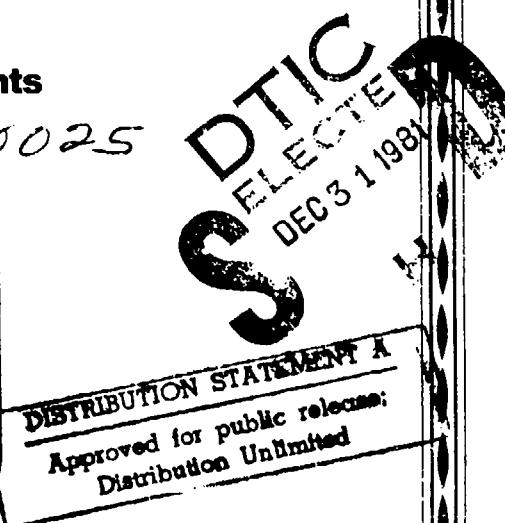
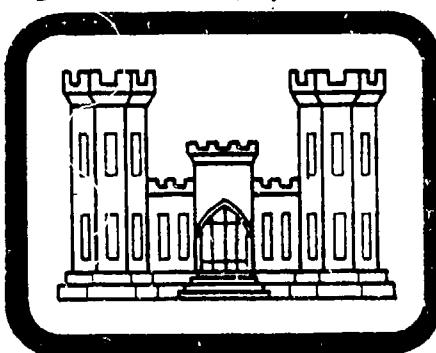
OWNER: ESTATE OF URBAN F. RICKARD

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

prepared by

Woodward-Clyde Consultants

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DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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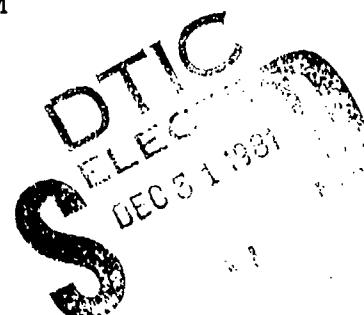
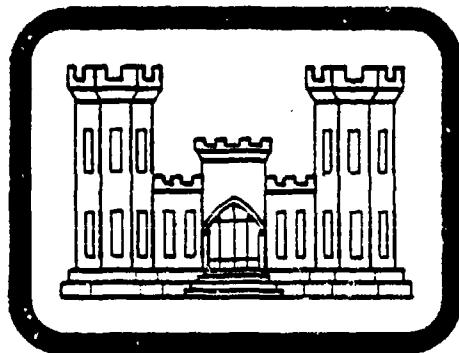
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DELAWARE RIVER BASIN
HORNBECKS CREEK

LOWER RICKARDS DAM
PIKE COUNTY, PENNSYLVANIA

NDI NO. PA 01107
DER NO. 52-103

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



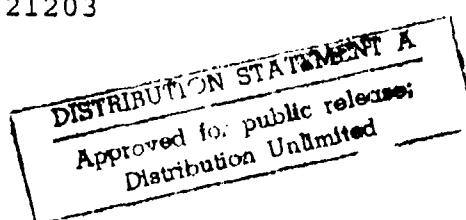
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Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

July 1981



PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Lower Rickards Dam
County Located: Pike County
State Located: Pennsylvania
Stream: Hornbecks Creek
Coordinates: Latitude 41° 13.4'
Longitude 74° 55.7'
Date of Inspection: April 28, 1981

Lower Rickards is a privately owned dam used for recreational purposes. The dam is in poor condition and the spillway is in good condition.

In accordance with the criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "Significant" hazard classification is the 100-Year Flood to one-half the Probable Maximum Flood. Based on the small capacity of the reservoir and the fact that no loss of life is likely during failure of this structure, the 100-Year event has been selected as the spillway design flood.

Hydrologic and hydraulic computations presented in Appendix B indicates that the spillway structure is not capable of discharging the 100-Year event. Thus, the spillway is considered to be "Inadequate".

It is recommended that the following measures be undertaken immediately. Items (1) and (2) should be performed under the supervision of a registered professional engineer with experience in the design and construction of dams.

- (1) The spillway capacity should be increased consistent with the analysis in this report or an independent hydrologic/hydraulic analysis which includes the effect of the upstream Rickards Lake Dam.
- (2) The embankment in the vicinity of the outlet conduit should be monitored and evaluated in terms of long-term stability.
- (3) The upstream embankment slope should be monitored for increased damage to the embankment. If waves and/or ice action reduce the crest width, the upstream embankment should be repaired and protected from further wave or ice action.

LOWER RICKARDS DAM, NDS I.D. NO. PA 01107

- (4) The operational status of the upstream pond drain control should be investigated and repairs made, if necessary.
- (5) Trees and stumps should be removed for a distance of at least 10 feet downstream of the embankment toe.
- (6) Possible seepage through the dam between the outlet and the spillway should be monitored for increase in quantity or development of turbidity.

Because of the potential for property damage in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented for this facility. This procedure should be coordinated with local authorities and should include a method of warning downstream residents that high flows are expected. In addition, an operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

Mary F. Beck

Mary F. Beck, P.E.
Pennsylvania Registration 27447E
Woodward-Clyde Consultants

July 17, 1981
Date



John H. Frederick Jr.

John H. Frederick, Jr., P.E.
Maryland Registration 7301
Woodward-Clyde Consultants

July 17, 1981
Date



APPROVED BY:

James W. Peck

James W. Peck
Colonel, Corps of Engineers
Commander and District Engineer

28 July 81
Date

OVERVIEW
LOWER RICKARDS DAM, PIKE COUNTY, PENNSYLVANIA



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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
LOWER RICKARDS DAM
NATIONAL ID NO. PA 01107
DER NO. 52-103

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lower Rickards Dam is about 10 feet high and 620 feet long impounding a 60 acre-foot reservoir within a 1.42 square mile watershed. There is no information available concerning the interior construction of this dam. The upstream embankment slope is vertical at and above the waterline. Below the waterline the upstream embankment slope is fairly flat. The embankment crest ranges from 11 to 15 feet wide, typically about 12 feet, and is well protected by grass. The downstream embankment slope ranges from about 2.9H:1V at the maximum section to 4H:1V near the right abutment and 8H:1V near the left abutment. Plan and cross-section views of the dam are shown on Plates 2 and 3, Appendix E.

The spillway at the right end of the dam is a variable width channel up to 30 feet wide with a low concrete weir about one foot high and one foot thick along the downstream edge of the dam crest. The approach channel to the weir is about 30 feet long and six inches below the weir crest. The channel downstream of the weir appears to be excavated out of natural material and curves to the left, approximately parallels the embankment toe for 300 feet, to join the original channel bed. A 15-inch diameter corrugated metal pipe is located at the maximum section approximately 300 feet from the right abutment. The control is located upstream of the embankment under water. The pipe discharges through a concrete end wall which has been extended to the sides and top by a dry stone wall.

b. Location. The dam was constructed across Hornbecks Creek about five miles upstream of the confluence of Hornbecks Creek with the Delaware River. The site, about three miles west of the intersection of U.S. Route 209 with Pennsylvania Route 739, is in Delaware Township, Pike County, Pennsylvania. The dam and reservoir are located on USGS Quadrangle Map entitled "Lake Maskenozha, Pennsylvania and New Jersey" at coordinates N 41° 13.4' W 74° 55.7'. A regional location plan of Lower Rickards Dam is included as Plate 1, Appendix E.

c. Size Classification. The dam is classified as a "Small" size dam by virtue of its less than 40 foot height and less than 1,000 acre-feet storage capacity to the top of the dam.

d. Hazard Classification. A "Significant" hazard classification is assigned consistent with the dam's location above a residential community and the potential for property damage with few or no lives lost. See Section 3.1, paragraph e.

e. Ownership. Lower Rickards Lake is part of the estate of Urban F. Rickard. All correspondence should be addressed to Mrs. Clara Rickard, Box 94, Park Road, Dingman's Ferry, Pennsylvania 18328.

f. Purpose of Dam. The purpose of this dam is private recreational usage.

g. Design and Construction History. There are no records known to exist for this dam. The only information available concerning the history of this dam is that it was probably built in 1954 or 1955 by Urban F. Rickard at the site of a previously existing dam.

h. Normal Operating Procedures. Reservoir outflow is controlled by the spillway at the right end of the dam. All flows discharge over the spillway crest at elevation 1070.

1.3 Pertinent Data.

A summary of pertinent data for Lower Rickards Dam is presented as follows.

a.	Drainage Area (square miles)	1.42
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood	unknown
	At Minimum Embankment Crest	110

c.	Elevation (feet above MSL) (1)	
	Top of Dam	1071.1
	Spillway Crest	1070.0
	Pond Drain Outlet Invert	1061.4
d.	Reservoir (feet)	
	Length at Normal Pool	1700
	Length at Maximum Pool (est)	1950
e.	Storage (acre-feet)	
	Normal Pool (est)	43
	Top of Dam (est)	60
f.	Reservoir Surface (acres)	
	Normal Pool	15
g.	Dam Data	
	Type	Earth/rockfill
	Length (excluding spillway)	620
	Side Slopes	
	Upstream (above water line)	vertical
	Downstream	2.9H:1V to 8H:1V
	Volume	3000 cu. yd.
	Height (above pond drain invert)	9.7 feet
	Crest Width	11 to 15 feet
	Cutoff	unknown
	Grout Curtain	unknown
h.	Spillway	
	Type	Concrete weir
	Elevation at Crest	1070.0 feet
	Length	30±
i.	Pond Drain	
	Type	15-inch diameter corrugated metal pipe with closure at upstream end
	Length	unknown
	Inlet Invert Elevation	unknown
	Outlet Invert Elevation	1061.4

(1) Spillway crest elevation assumed to be 1070 from USGS map.
All other elevations are relative to this elevation.

SECTION 2 ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of the available engineering data on Lower Rickards Dam is attached as Appendix B. There is no original engineering data known to exist for this structure.

b. Design Features. The principal design features of Lower Rickards Dam are illustrated on the plan, profile and section enclosed in Appendix E as Plates 2 through 4. All information was obtained from the visual inspection of the dam. A detailed description of the design features is presented in Section 1.2, paragraph a, and pertinent data relative to the structure are presented in Section 1.3.

2.2 Construction.

There is no known construction history for this dam.

2.3 Operational Data.

There are no operational records maintained by the Owner. There are no minimum flow requirements for the downstream channel. No water level measurements or rainfall records are maintained within the watershed.

2.4 Evaluation.

There is no original engineering data to be evaluated for this structure.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. Observation and comments of the field inspection team are summarized in the checklist enclosed herein as Appendix A and are summarized and evaluated as follows. In general, the embankment is considered to be in poor condition and the spillway is in good condition.

b. Dam. The vertical alignment of the dam was checked and the profile is shown on Plate 3, Appendix E. The minimum crest elevation is 1071.1 at and beyond the left abutment. Embankment crest elevations range from 1071.5 to 1072. The upstream embankment slope at the waterline is irregular with about a 1.5 foot vertical bench probably resulting from wave and ice action. Below the waterline the embankment is protected with broken stone and appears to be fairly flat. Above the waterline, the embankment is protected by a heavy stand of grassy vegetation with occasional large stones exposed, Photograph No. 7.

The crest of the dam ranges from 11 to 15 feet wide and is protected with a heavy stand of grass. Vehicle ruts are visible through the vegetation but do not appear to have significantly damaged the embankment. (Vehicles ford the upstream spillway channel to the road on the right abutment.) As shown on Plate 3, Appendix E, the crest profile is uneven with nearly a foot difference in elevation between the left abutment and the maximum crest elevation. The crest is also warped in a direction perpendicular to the profile. Measurements of the downstream embankment slope range from 2.9H:1V to as flat as 8H:1V. In general, steeper slope measurements were near the maximum section with flatter slope measurements towards each abutment. The definition between embankment and natural ground along the downstream toe is difficult to discern. The downstream embankment slope is protected by a stand of grassy vegetation, weeds and briars. Trees and large woody vegetation have recently been cut from the downstream embankment slope, although many trees are still growing immediately downstream of the toe and a few trees may be on the embankment. Downstream embankment materials include boulders, as evidenced by surficial materials, Photograph 10, and voids in the embankment materials, Photographs 5, 6 and 10. Voids were noted in the downstream embankment materials in the area between the spillway and the outlet pipe at the dry stone wall around the outlet pipe and left of the wall, see Sheet 5A, Appendix A. Voids measured up to four feet deep.

Evidence of possible seepage through the embankment was limited to a few small puddles of standing water in the gulley between the embankment and the downstream channel, shown on Sheet 5A, Appendix A. The elevation of these puddles appear to be at or below the water surface elevation in the downstream spillway channel. Backwater has submerged the pond drain outlet to a depth of 11 inches. At the time of the inspection, no evidence could be detected indicating seepage through the embankment in the vicinity of the pond drain outlet and the dry stone retaining wall.

c. Appurtenant Structures.

1. Spillway. The spillway at the right end of the dam appears to be constructed entirely in natural materials. The variable width channel through the right abutment area is stabilized by a one-foot high concrete weir downstream of the embankment crest. The effective length of the weir is 29 feet; the weir extends at least one-foot under the embankment vegetation root mass. The channel upstream of the weir is about six inches below the weir crest and is protected with broken stone. The channel downstream of the dam curves towards the left, about 60 feet downstream of the dam and is oriented parallel to the dam before rejoining the natural stream channel at the dam's maximum section. The right side of the spillway channel, both upstream and downstream of the weir, is formed by natural abutment materials, which in the vicinity of the weir are eroding. The left channel wall upstream of the weir is protected by vegetation and no significant erosion was noted. The left channel wall in the vicinity of the embankment is on the inside of the curve where it is less subject to erosion by large spillway flows. There is some concrete deterioration in the middle and on the downstream face of the weir.

2. Outlet Works. A 15-inch diameter corrugated metal pipe exits the downstream face of the dam at elevation 1061.4 through a concrete end wall. A dry stone retaining wall extends the end wall both vertically and horizontally, see Photograph 4. The concrete wall appears to have deflected outward. The lower portion of the dry stone retaining wall has bulged outward, permitting the upper portion to settle. The void shown in Photograph 5 on top of the dry retaining wall is about 3.5 feet deep and gently sloping downward in the upstream direction. A few feet to the left of the retaining wall is a void in the embankment about four feet deep, Photograph 6. Under the base of the retaining wall, to the right of the outlet, soil is exposed. It appears as if a block of the wall has moved outward, permitting the upper portion to subside.

The pond drain inlet is upstream and under water. Discharge through the pond drain is controlled upstream of the embankment. The pond drain key is bent and is under water. It is unknown if the control is operational.

d. Reservoir. The reservoir side slopes are flat to moderate and generally wooded or grass to the water's edge. A small amount of debris, principally logs, was noted around the edge of the lake.

About 200 feet upstream of Lower Rickards Reservoir is Rickards Lake, DER No. 52-82, the subject of a June 1981 Phase I Inspection Report. Rickards Lake is also part of the Estate of Urban F. Rickard. About 2500 feet upstream of Rickards Reservoir is Long Ridge Reservoir, which has also been scheduled for Phase I inspection in July 1981.

e. Downstream Channel. The houses shown on Plate 1 between the dam and the first downstream road are not subject to flooding in the event of a dam failure. Between the first and second downstream roads, portions of the channel appear to have been deepened with the excavated material placed on the right bank to form a dike and a portion of the channel has been realigned as shown on Plate 1. The first 90 degree bend shown in Photograph 14 is about 1,800 feet downstream of the dam and immediately upstream of the house closest in elevation to the channel. The house is about three feet above the channel bottom. Dam failure, when combined with storm runoff, would be expected to jump the channel at this point and flood the house. Other houses in the area are four to six feet above the channel bottom. Shortly downstream of the road, Hornbecks Creek enters Little Fawn Lake and there to Fawn Lake, also the subject of a Phase I Inspection report, June 1981. About 1.8 miles downstream of Lower Rickards Dam is Camp Log-N-Twig, where two buildings are built on the flood plain about three feet above channel. The remaining buildings are five or more feet above the stream level. Therefore, a "Significant" hazard classification for this structure is indicated.

3.2 Evaluation.

Inspection of the dam and appurtenant facilities indicates that the spillway is in good condition and the embankment is in poor condition.

The condition of the outlet system cannot be evaluated as the upstream intake control is under water and could not be inspected. The control should be exercised to insure its operational state and the key protected from further damage.

Inspection of the spillway indicates that progressive erosion is occurring at the right abutment and at the right end of the weir. It is judged that the abutment erosion and even possible erosion at the end of the weir do not threaten the integrity of the embankment. Otherwise, the spillway is considered to be in good condition.

The embankment is considered to be in poor condition consistent with the voids in the embankment, apparent movement of the dry stone wall, and the tree at the embankment toe. The large voids could be indicative of loss of embankment material, possibly as a result of rainfall. However, the voids could also be as a result of construction techniques as voids were also observed in the embankment between the outlet and the spillway. There are no records located in the State's files or verbal reports of the Owner's representative upon which to base an assessment of the causal mechanism. Detrimental to long term stability of earthen embankments is the presence of extensive tree root systems. When the trees die, the roots decay, forming channels through which water can percolate through the embankment. Although most of the trees have been removed from the embankment, the root systems of the trees at the toe can extend under and through the embankment to the upstream embankment slope. Thus, the trees should be cut and the stumps removed for a minimum of 10 feet beyond the embankment toe.

Possible seepage in the vicinity of the pools of standing water is assessed not to represent a threat to the embankment at this time. The area should be monitored for seepage which may increase in volume or develop turbidity.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Operation procedures are discussed in Section 1.2. Operation of the dam does not require a dam tender. All flow discharges through the spillway. There are no written operation or maintenance procedures for this structure.

4.2 Maintenance of the Dam.

The recent maintenance provided to the embankment was under the direction of Mrs. Clara Rickard.

4.3 Maintenance of Operating Facilities.

Operational facilities are limited to the control on the upstream of the pond drain. It is unknown whether any maintenance has been provided or required by the control.

4.4 Warning Systems in Effect.

There are no formal warning systems or procedures established to be followed during periods of exceedingly heavy rainfall.

4.5 Evaluation.

It is judged that the current operating procedure which does not require a dam tender is a realistic means of operating the relatively simple control facilities of Lower Rickards Lake Dam.

There are no written operational or maintenance procedures or any type of warning system. Maintenance and operating procedures should be developed, including a checklist of items to be observed, operated and inspected on a regular basis. Since a formal warning system does not exist, one should be developed and implemented during periods of extreme rainfall. This procedure should consist of a method of notifying residents downstream that potentially high flows are imminent or dangerous conditions are developing.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Evaluation Data. There are no original design data for this structure nor are subsequent evaluation data available for review. The watershed has a maximum length of about 1.3 miles and a maximum width of about 1.5 miles for a total drainage area of about 1.42 square miles. Approximately 1.3 square miles are controlled by Rickards Lake Dam, located approximately 250 feet upstream of Lower Rickards Reservoir. The watershed is almost 100 percent wooded with little residential development. While some residential development is occurring within the watershed, runoff characteristics are not expected to change significantly in the near future.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "Significant" hazard classification is the 100-year Flood to one-half the probable maximum flood. Based on the relatively small capacity of the reservoir and the fact that no loss of life is likely during the failure of this structure, the 100-year event has been selected as the spillway design flood.

b. Experience Data. No reservoir level records or rainfall records are maintained for this dam by the Owner. There are no records or reports of the previous maximum high water level.

c. Visual Observations. At the time of the inspection, the only condition observed that would indicate a reduced spillway capacity during an extreme event is the low embankment elevation towards the left end of the dam which would be the first areas to experience overtopping. At the point of the minimum embankment elevation, the embankment height is very low, less than about four feet. Visual inspection indicates that overtopping water would flow away from the embankment toe towards the original stream channel. Other observations regarding the condition of the downstream channel spillway and reservoir are presented in Appendix A and discussed in greater detail in Section 3.

d. Overtopping Potential. The overtopping potential of this dam was estimated by comparing the peak 100-year inflow value with the peak spillway discharge value. Calculations are included in Appendix D. The peak 100-year storm inflow value was estimated according to procedures contained in "Regional Frequency Study, Upper Delaware and Hudson River Basins, New

York District", November 1974. The effect of upstream Rickards Lake was not considered in determining the peak inflow value to Lower Rickards Lake. The peak inflow value was calculated to be 507 cfs, greater than the estimated spillway capacity of about 110 cfs, and it can reasonably be assumed that the Lower Rickards embankment would be overtopped during the 100-year event.

e. Spillway Adequacy. As the spillway is not considered capable of discharging the 100-year event peak inflow, the spillway is considered to be "Inadequate".

f. Downstream Conditions. About 250 feet downstream of the dam is the first downstream road. Discharge is conveyed under the road via one four-foot diameter CMP and two two-foot diameter CMP culverts. The houses shown on Plate 1, Appendix E, are not expected to be flooded during a dam failure. The first downstream house to be affected by a dam failure is located about 1700 feet downstream of the dam. The house is about three feet above the channel bottom and is downstream of the first 90 degree bend in the realigned channel. Dam failure flow, when combined with storm runoff, would be expected to jump the channel at this point and flood the house. About 1.8 miles downstream of Lower Rickards Dam is Camp Log-N-Twiq where several buildings are built along the edge of the pond and stream in the flood plain. It is estimated that three feet of water in the stream would be required to put water in the lower level of the two buildings closest in elevation to the stream. It is estimated that failure of Lower Rickards Dam would not cause loss of life at the camp. Therefore, a "Significant" hazard potential classification is indicated.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations indicate a potential for embankment instability in the vicinity of the pond drain outlet. The voids behind the dry stone retaining wall and in the embankment near the retaining wall, together with the apparent outward deflection of the retaining wall, indicate possible removal of embankment material. The material may be being removed by seepage through the embankment or, more likely, by rainfall infiltration through the embankment. Construction practices may have also resulted in the voids in the embankment. The area should be monitored and the stability evaluated. There is no other evidence to indicate that seepage through or under the embankment poses a potential threat to the embankment stability. Overtopping of the left abutment area adjacent to the embankment by a few inches is also judged not to pose a threat to the embankment stability.

b. Design and Construction Data. No design or construction data exists for this structure. All data concerning the physical features of the dam were obtained from the visual observations.

c. Operating Records. There are no operational records for this structure.

d. Post-Construction Changes. No post-construction changes are known to have been made to this structure.

e. Embankment Stability. There were no embankment stability evaluations available for review. Based on the low dam height, fairly wide crest and generally flat downstream embankment slopes, the dam appears to be stable at the present time provided that embankment material is not being removed in the vicinity of the outlet pipe.

f. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. Since the dam is qualitatively assessed to be stable at the present time under static loading conditions, it can also reasonably be considered stable under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection indicates that Lower Rickards Lake Dam is in poor condition and the spillway is in good condition.

In accordance with the criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "Significant" hazard classification is the 100-year Flood to one-half the Probable Maximum Flood. Based on the small capacity of the reservoir and the fact that no loss of life is likely during failure of the structure, the 100-year event has been selected as the spillway design flood.

Hydrologic and hydraulic computations presented in Appendix D indicate that the spillway structure is not capable of discharging the 100-year event while confining the dam outflow to the design spillway. Thus, the spillway is considered to be "Inadequate".

b. Adequacy of Information. The combined visual inspection and simplified calculations presented in Appendix D were sufficient to indicate that remedial repairs may be required for this structure.

c. Urgency. It is recommended that the measures presented in Section 7.2 be implemented as specified.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following measures be undertaken immediately. Items (1) and (2) should be performed under the supervision of a registered professional engineer experienced in the design and construction of dams.

- (1) The spillway capacity should be increased consistent with the analysis in this report or an independent hydrologic/hydraulic analysis which includes the effect of the upstream Rickards Lake Dam.
- (2) The embankment in the vicinity of the outlet conduit should be monitored and evaluated in terms of long-term stability.

- (3) The upstream embankment slope should be monitored for increased damage to the embankment. If waves and/or ice action reduce the crest width, the upstream embankment should be repaired and protected from further wave or ice action.
- (4) The operational status of the upstream pond drain control should be investigated, and repairs made, if necessary.
- (5) Trees and stumps should be removed for a distance of at least 10 feet downstream of the embankment toe.
- (6) Possible seepage through the dam between the outlet and the spillway should be monitored for increase in quantity or development of turbidity.

b. Operation and Maintenance Procedures. Because of the potential for property damage in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented for this facility. This procedure should be coordinated with local authorities and should include a method of warning downstream residents that high flows are expected. In addition, an operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam Lower Rickards Dam

County Pike State Pennsylvania

NDI# PA 01107 DER# 52-103 Type of Dam Earth

Hazard Category Significant

Date(s) Inspection April 28, 1981

Weather Showers Temperature 80's

Pool Elevation at Time of Inspection 1070.2 M.S.L.

Tailwater at Time of Inspection 1062.3 M.S.L.

Inspection Personnel:

Mary F. Beck

Paul F. Marano

Raymond S. Lambert

Vincent McKeever

Richard E. Mabry

John R. Frederick (Principal)

Mary F. Beck

Recorder

Remarks:

Mr. Clifford Dennis, R.K.R. Hess Associates, was on site as the Owner's representative.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

ANY NOTICEABLE
SEEPAGE

N/A

STRUCTURE TO
ABUTMENT/
EMBANKMENT
JUNCTIONS

N/A

DRAINS

N/A

WATER PASSAGES

N/A

FOUNDATION

N/A

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

SURFACE CRACKS
CONCRETE SURFACES

N/A

STRUCTURAL CRACKING

N/A

VERTICAL AND
HORIZONTAL
ALIGNMENT

N/A

MONOLITH JOINTS

N/A

CONSTRUCTION
JOINTS

N/A

EMBANKMENT

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
SURFACE CRACKS	<i>None observed</i>	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	<i>None observed</i>	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES		Voids were noted in the downstream embankment slope, particularly in the vicinity of the outlet and the embankment between the outlet and spillway.
VERTICAL AND HORIZONTAL ALIGN- MENT OF THE CREST		See Sheet 5A and Plate 3
RIPRAP FAILURES		No upstream riprap, upstream embankment face "benched" at waterline.

EMBANKMENT

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

JUNCTION OF
EMBANKMENT
AND ABUTMENT,
SPILLWAY AND
DAM

All junctions in good condition.

ANY NOTICE-
ABLE SEEPAGE

*Slight standing water/seepage near
right end of the embankment.*

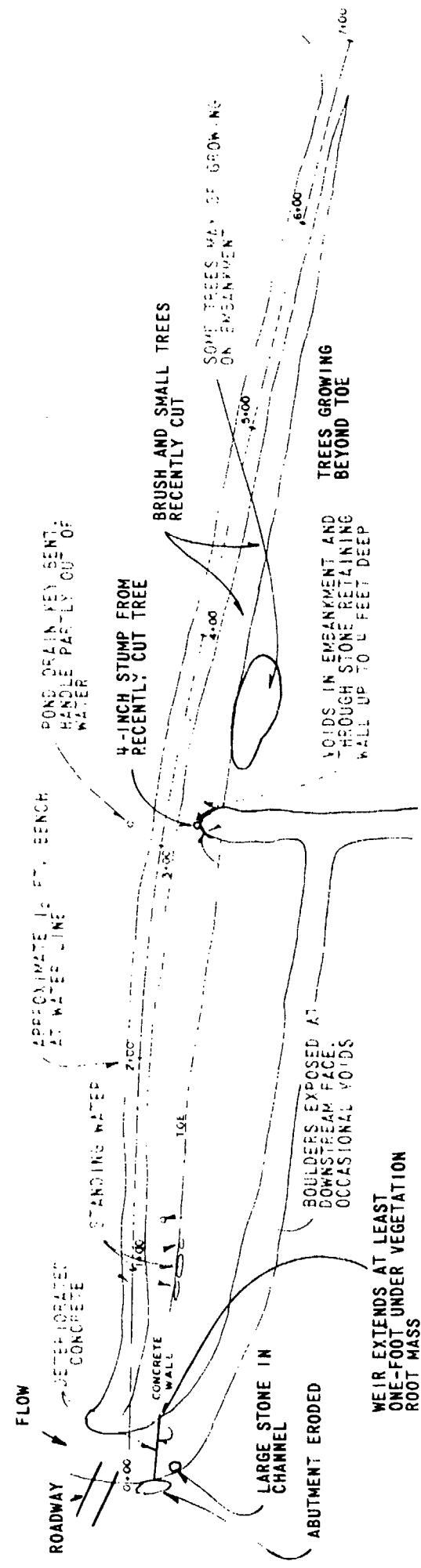
STAFF GAGE
AND RECORDER

None

DRAINS

None

VEGETATION AND VEGETATION
EMBANKMENT NOT SIGNIFICANTLY
IMPAVED



FIELD OBSERVATION PLAN
LOWER RICKARDS DAM

SHEET 5A OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT		<i>Conduit is 15-inch diameter CMP</i>
INTAKE STRUCTURE		<i>Underwater</i>
OUTLET STRUCTURE		<i>The CMP outlets through a concrete end wall which has been extended vertically and laterally by a dry stone retaining wall. The top of the concrete wall and retaining wall appears to have rotated downstream.</i>
OUTLET CHANNEL		<i>The channel between the outlet and the stream appears stable.</i>
EMERGENCY GATE		<i>The above CMP conduit. A key to operate the gate/valve could be seen underwater. It is unknown when the control was last operated.</i>

UNGATED SPILLWAY

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
------------------------------	---------------------	-----------------------------------

CONCRETE WEIR

The low weir is at the downstream edge of the embankment crest. The weir is in good condition with some concrete deterioration. The left end of the weir extends under the vegetation root mass.

APPROACH CHANNEL

The channel through the dam to the weir is in good condition with no significant erosion of the embankment. Erosion of the abutment does not affect the safety of the dam.

DISCHARGE CHANNEL

The channel curves toward the embankment midpoint, roughly paralleling the embankment for about 300 feet. The channel appears stable and does not threaten the embankment.

BRIDGE AND PIERS

None

GATED SPILLWAY

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

TYPE

None

APPROACH CHANNEL

N/A

DISCHARGE CHANNEL

N/A

BRIDGE AND PIERS

N/A

GATES AND
OPERATION
EQUIPMENT

N/A

INSTRUMENTATION

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

MONUMENTATION/
SURVEYS

None

OBSERVATION WELLS

None

WEIRS

None

PIEZOMETERS

None

OTHER

None

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

SLOPES

The reservoir side slopes are flat to moderate and vegetated to the water's edge with woods and brush.

SEDIMENTATION

No significant sedimentation affecting flood water storage was noted.

WATERSHED

The watershed slopes are moderate to steep. The watershed is completely wooded with limited residential development. About 200 feet upstream of the reservoir is Rickards Lake, about nine feet high. About 2500 feet upstream of Rickards Lake is a smaller reservoir impounded by a nine foot high dam.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

CONDITION

(OBSTRUCTIONS,
DEBRIS, ETC.)

Spillway discharge is conveyed under the roadway 250 feet downstream via 4-foot CMP and 2-two foot CMP culverts. The four foot wide channel flows about 1500 feet where it makes a 90-degree turn right to the road when it makes a 90-degree turn left in its original channel.

SLOPES

The valley gradient is about 0.013.

APPROXIMATE NO.
OF HOMES AND
POPULATION

The houses subject to flooding in the event of a failure are located upstream of the second downstream road. The first house subject to flooding is about three feet above the channel bottom and is downstream of the first 90-degree bend. Other houses in the area are four to six feet above the channel bottom.

APPENDIX

B

(

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Lower Rickards Dam

NDI NO. PA 01107 DER NO. 52-103

ITEM	REMARKS
AS-BUILT DRAWINGS	<i>None</i>
REGIONAL VICINITY MAP	<i>Plate 1, Appendix E</i>
CONSTRUCTION HISTORY	<i>None known</i>
TYPICAL SECTIONS OF DAM	<i>See Appendix E</i>
OUTLETS - PLAN	<i>None</i>
DETAILS	<i>None</i>
CONSTRAINTS	<i>None</i>
DISCHARGE RATINGS	<i>None</i>

ITEM	REMARKS
RAINFALL/ RESERVOIR RECORDS	<i>None</i>
DESIGN REPORTS	<i>None</i>
GEOLOGY REPORTS	<i>See Appendix F</i>
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	<i>None</i>
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	<i>None</i>
POST CONSTRUCTION SURVEYS OF DAM	<i>None</i>

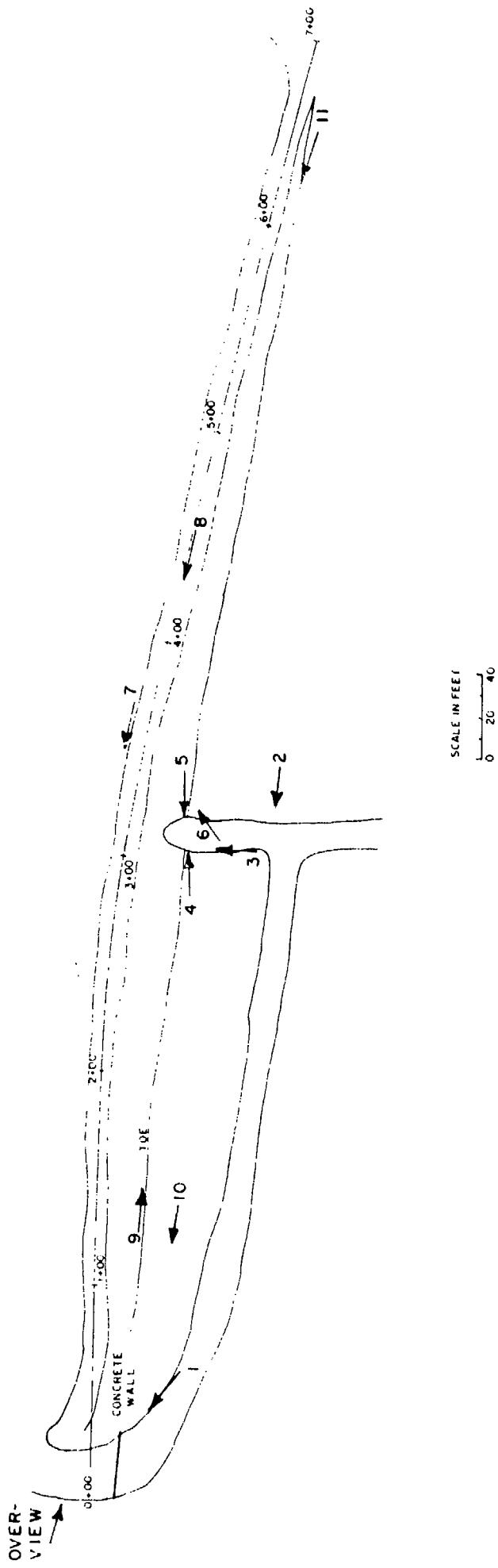
ITEM	REMARKS
BORROW SOURCES	<i>Unknown</i>
MONITORING SYSTEMS	<i>None</i>
MODIFICATIONS	<i>None</i>
HIGH POOL RECORDS	<i>None</i>
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	<i>None</i>
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	<i>None</i>
MAINTENANCE OPERATION RECORDS	<i>None</i>

ITEM	REMARKS
SPILLWAY PLAN	<i>See Appendix E</i>
SECTIONS	<i>See Appendix E</i>
DETAILS	<i>See Appendix E</i>
OPERATING EQUIPMENT PLANS AND DETAILS	<i>None</i>
MISCELLANEOUS	<ol style="list-style-type: none">1. <i>Information in the Department of Environmental Resources files refer to the dam previously existing at the site.</i>2. <i>Two aerial photographs were supplied.</i>

APPENDIX

C

PHOTOGRAPH LOCATION PLAN
LOWER RICKARDS DAM
PLATE C-1





SPILLWAY AT RIGHT ABUTMENT.

PHOTOGRAPH 1



CONFLUENCE OF SPILLWAY CHANNEL (UPPER LEFT)
AND POND DRAIN CHANNEL (RIGHT).

PHOTOGRAPH 2



POND DRAIN CHANNEL.

PHOTOGRAPH 3



POND DRAIN OUTLET AND RETAINING WALL.

PHOTOGRAPH 4



DARK SPOT IN CENTER OF PICTURE ADJACENT TO WALL IS A VOID.

PHOTOGRAPH 5



VOID IN EARTH/ROCK FILL MATERIAL A FEW FEET LEFT OF POND DRAIN.

PHOTOGRAPH 6



UPSTREAM EMBANKMENT SLOPE AT WATERLINE.

PHOTOGRAPH 7

PHOTOGRAPH 8

EMBANKMENT CREST.





VIEW OF DOWNSTREAM EMBANKMENT SLOPE FROM RIGHT END.
SMALL TREES AND BUSH RECENTLY CUT.

PHOTOGRAPH 9



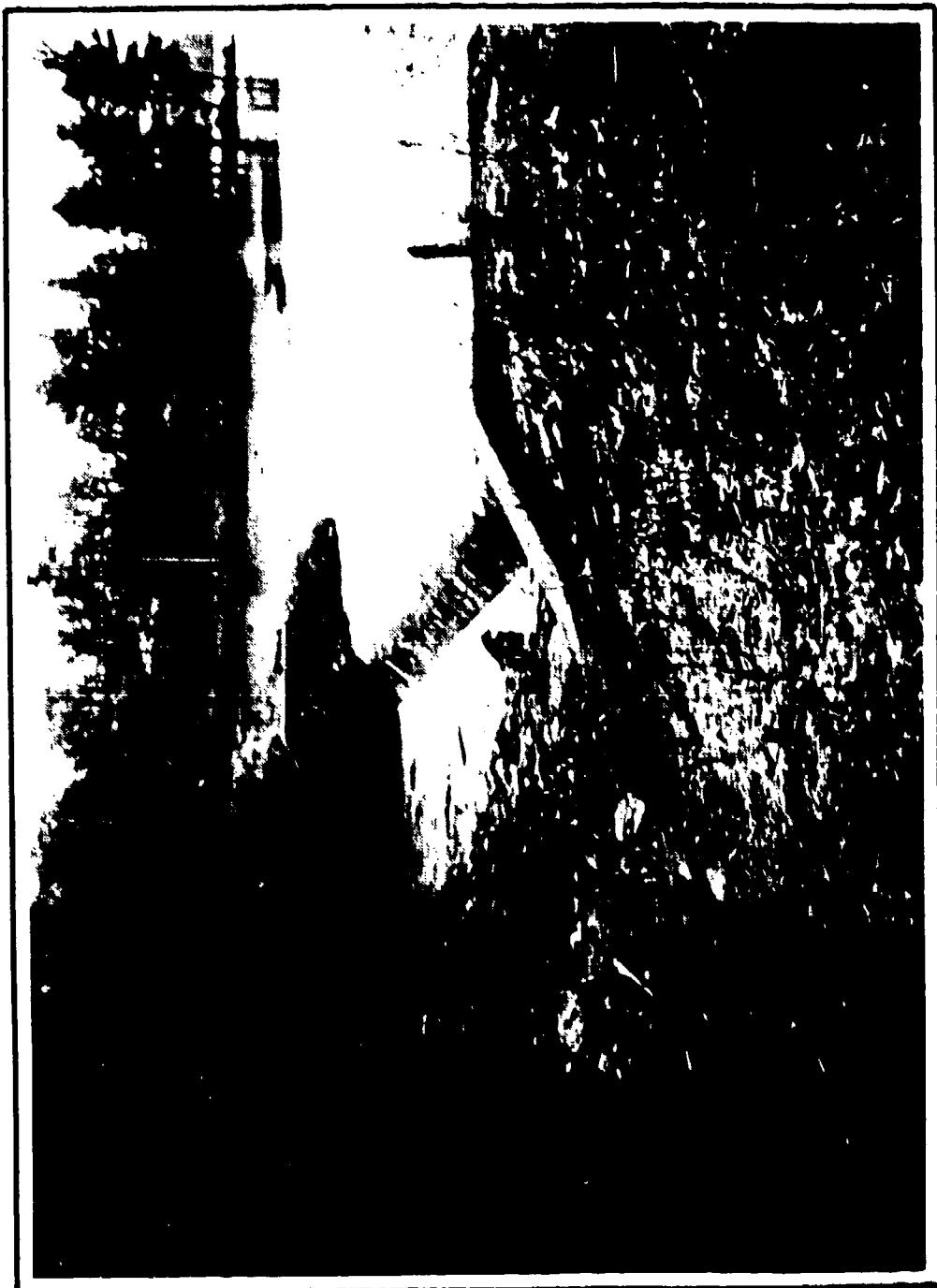
VOIDS IN DOWNSTREAM EMBANKMENT
NEAR LOCATION OF STANDING WATER.

PHOTOGRAPH 10



VIEW OF DOWNSTREAM EMBANKMENT FROM LEFT END.
TREES APPEAR TO BE BEYOND EMBANKMENT TOE.

PHOTOGRAPH 11



SPILLWAY OF FIRST UPSTREAM DAM, RICKARDS LAKE DAM.

PHOTOGRAPH 12



SPILLWAY OF SECOND UPSTREAM DAM, LONG RIDGE DAM.

PHOTOGRAPH 13



HOUSE AT SECOND DOWNSTREAM ROAD IS ABOUT
THREE FEET ABOVE CHANNEL BOTTOM.

PHOTOGRAPH 14



SPILLWAY AT LEFT ABUTMENT OF DOWNSTREAM
FAWN LAKE DAM.

PHOTOGRAPH 15

APPENDIX

D

LOWER RICKARDS DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

Sheet 1 of 3

DRAINAGE AREA Wooded, with an approximately 5% slope, little
CHARACTERISTICS residential development

ELEVATION NORMAL

POOL (STORAGE CAPACITY): 1070.0 feet (43 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL

(STORAGE CAPACITY): 1071.1 feet (60 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: --

ELEVATION TOP DAM: 1071.1 feet

SPILLWAY

a. Elevation 1070.0 feet

b. Type Trapezodial channel through right abutment

c. Width 32 feet, estimated effective length

d. Length About 30 feet

e. Location Spillover at right abutment

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 15-inch CMP

b. Location Approximately 300 feet from spillway centerline

c. Entrance inverts Unknown, under water

d. Exit inverts 1061.4 feet

e. Emergency draindown facilities the 15-inch CMP

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location N/A

c. Records N/A

MAXIMUM NON-DAMAGING DISCHARGE: Not determined

BY MFB DATE 4/18/81
CHKD BY PEM DATE 6/16/81

SUBJECT Lower Rickards Dam
Hydrology / Hydraulics

SHEET 2 OF 3
JOB NO. _____

Classification (Ref: Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential classification is "Significant" as there would be appreciable economic loss with few lives lost in the event of a dam failure.
2. The size classification is "Small" based on its 9.7 ft height and 60 Ac-Ft capacity to the top of the dam.
3. The selected spillway design flood, based on size and hazard potential classification, is the 100-yr event.

Hydrology and Hydraulic Analysis

1. Original Data - none

2. Evaluation Data

Reservoir Volume

$$\Delta \text{Vol.} = \frac{1}{3} (A_1 + A_2 + \sqrt{A_1 A_2})$$

1070.0 ft. spillway crest elev.

1061.4 ft. pond drain outlet invert elev., assumed min. reservoir elev.

$$8.6 \text{ ft.} = h$$

$A_1 = 0$, assumed area at elev. 1061.4

$A_2 = 15 \text{ Ac.}$ measured from USGS map

$$\Delta \text{Vol.} = \frac{8.6}{3} (15) = 46.9 \text{ Ac-Ft. normal storage vol.}$$

1071.1 min. embankment elevation

1070.0

1.1 ft. $\times 15 = 16.5 \text{ Ac-Ft. flood water storage}$

$$46.9 + 16.5 = 59.5 \text{ Ac-Ft.}$$

Say 60 Ac-Ft total reservoir capacity

BY MFB DATE 6/9/81
CHKD. BY RCM DATE 6/16/81

SUBJECT Lower Rickards Dam
Hydrology / Hydraulics

SHEET 3 OF 1
JOB NO.

Spillway capacity

$$Q = C_L H^{3/2}$$

$L = 32$ ft. est. effective length
 $C \approx 3.0$ Ref. Brater & King, Handbook
of Hydraulics, 1976
Tab. 5-13

$$H = 1.1 \text{ ft}$$

$$Q = 3 \cdot 32 \cdot 1.1^{3/2} = 110 \text{ cfs}$$

100-yr event peak inflow value Ref. "Regional Frequency
Study, Upper Delaware and Hudson River Basins" Nov. 1974

$$\log Q_m = C_m + 0.87 \log A$$

where $C_m = 1.61$ from fig. 2

$A = 1.42$ sq. miles from USGS map

$$\log Q_m = 1.742$$

$$S = C_s - 0.05 \log A$$

where $C_s = 0.34$ from fig. 3

$$S = 0.34 - 0.05 \log 1.742$$

$$= 0.332$$

$$g = +0.9 \text{ from fig. 5}$$

$$\log Q_{100} = \log Q_m + K(p, g) S$$

$K(p, g) = 2.90$ from Pearson Type III
Distribution, Standard
Table found in most Hydrology
Texts.

$$= 1.742 + 2.9 \cdot 0.332 = 2.905$$

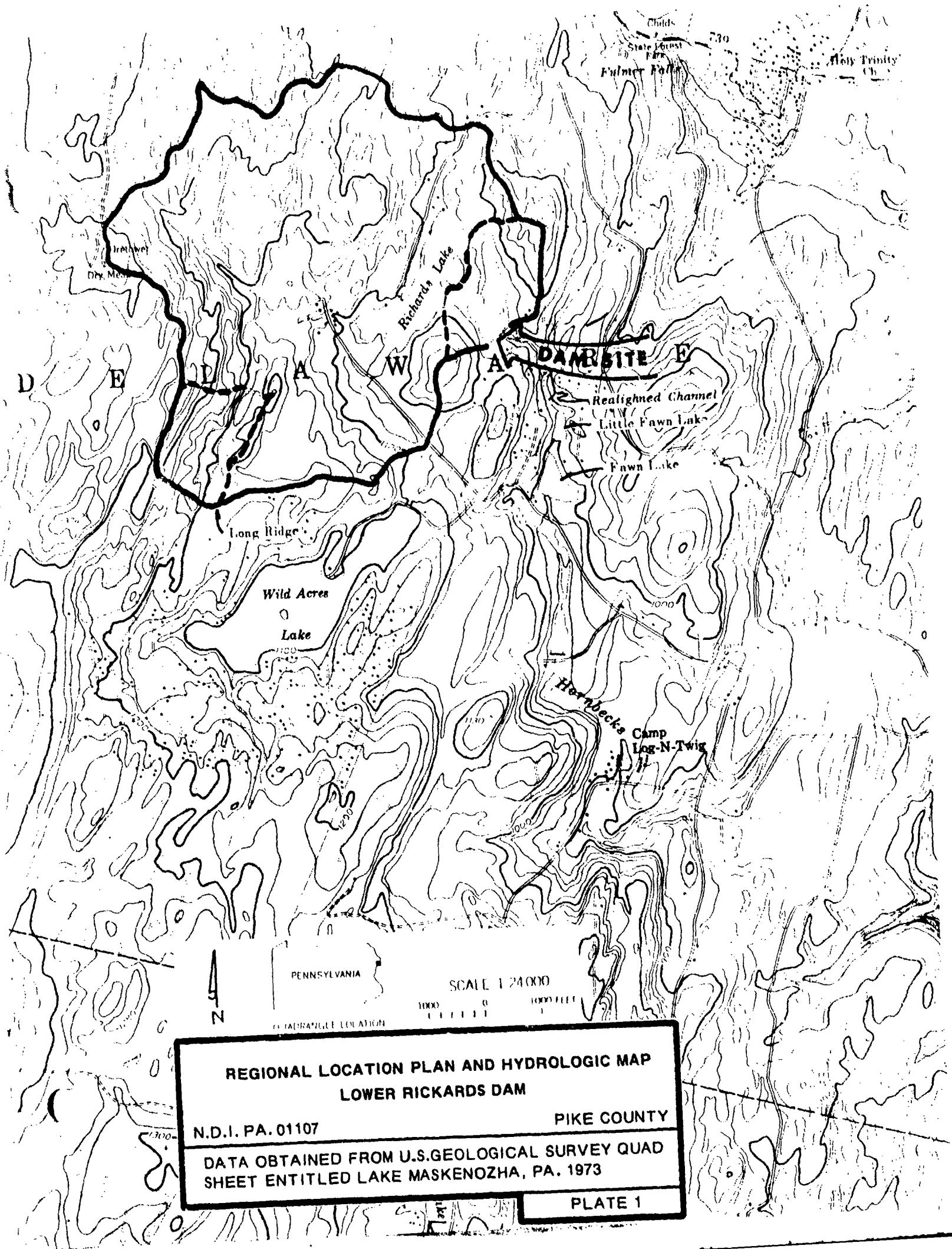
$$Q_{100} = 507 \text{ cfs}$$

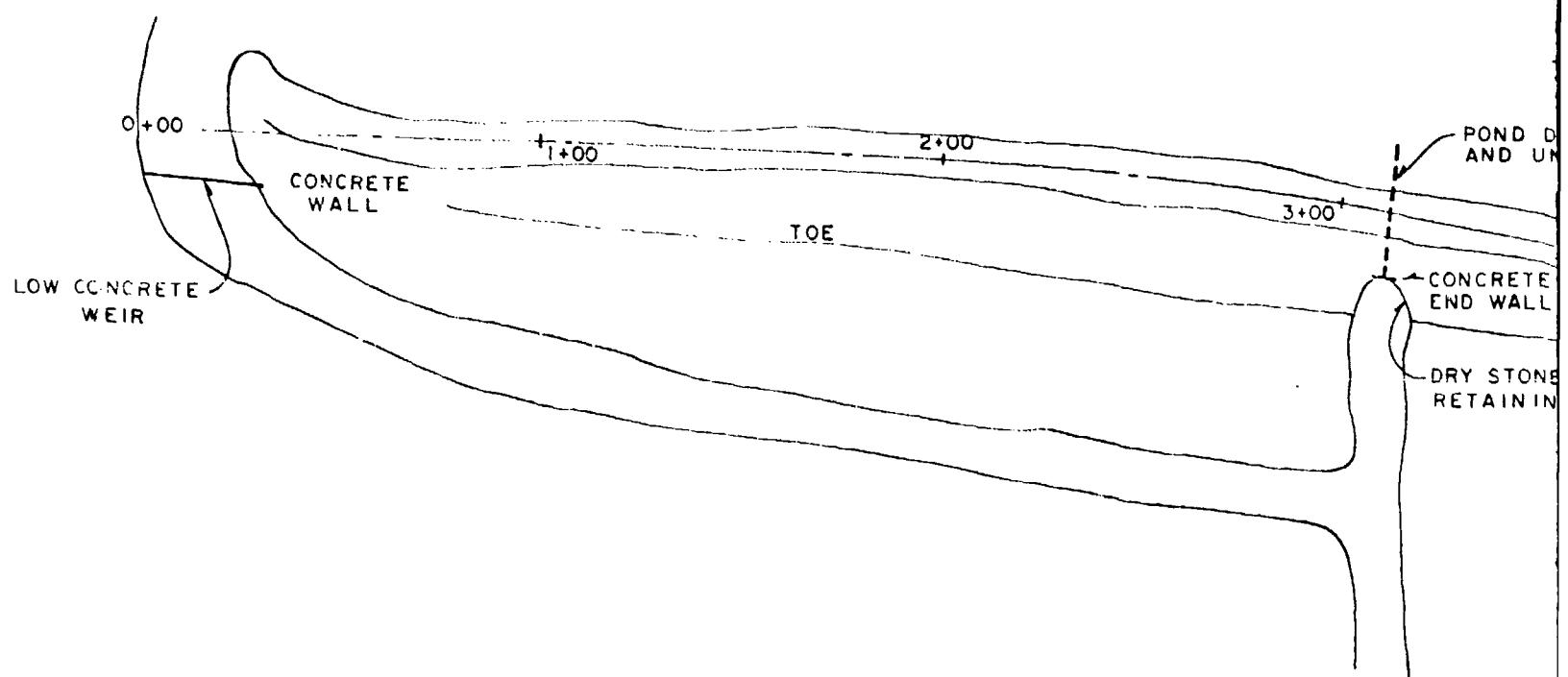
3. Spillway Adequacy - As $Q_{100} > Q_s$ (max. spillway capacity), the embankment and/or left abutment will be overtopped during the 100-yr event. Therefore, the spillway is considered "Inadequate".

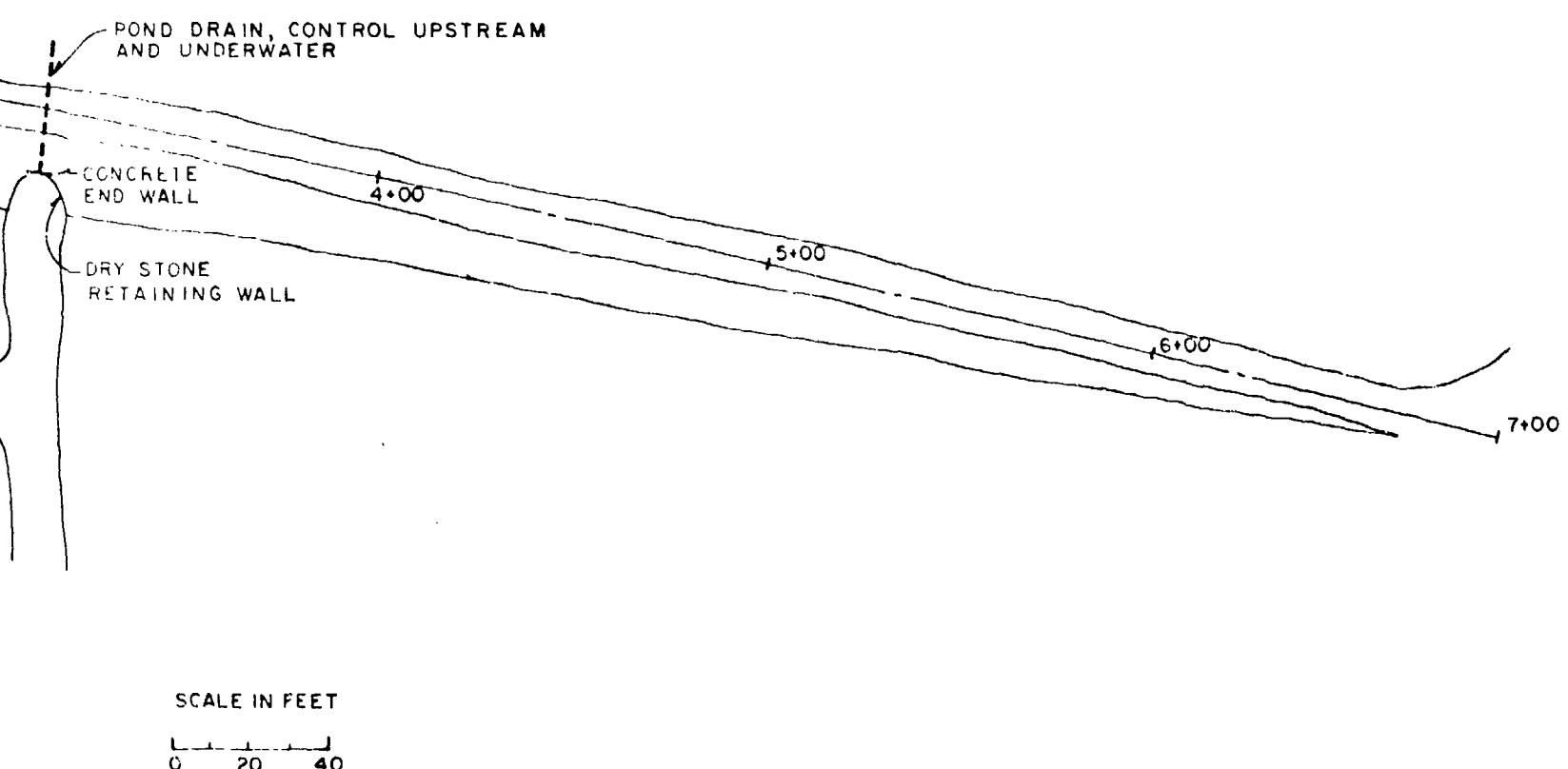
The above procedure is conservative as the available flood water storage in Rickards Lake is neglected.

APPENDIX

E



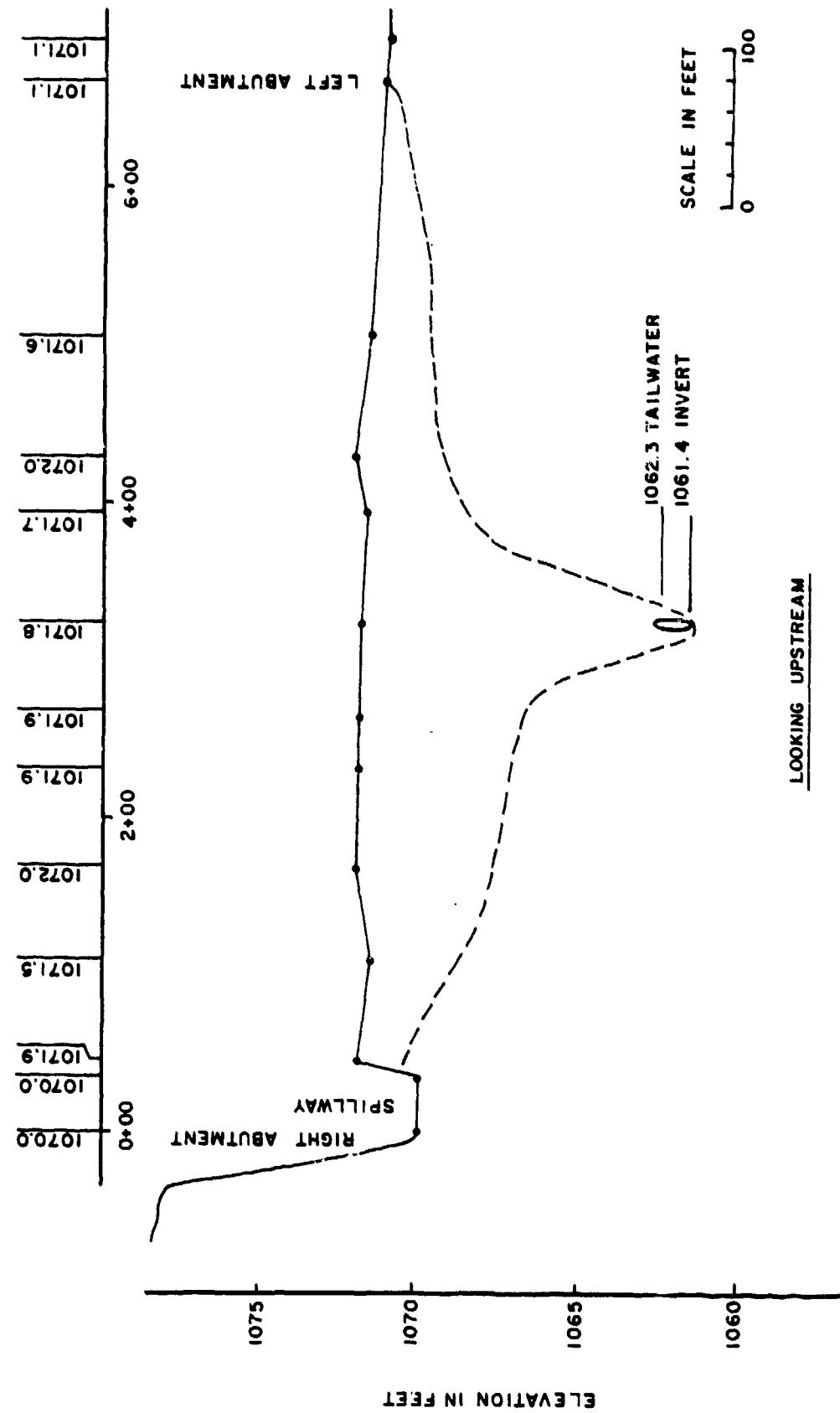




2

PLAN OF DAM
LOWER RICKARDS DAM

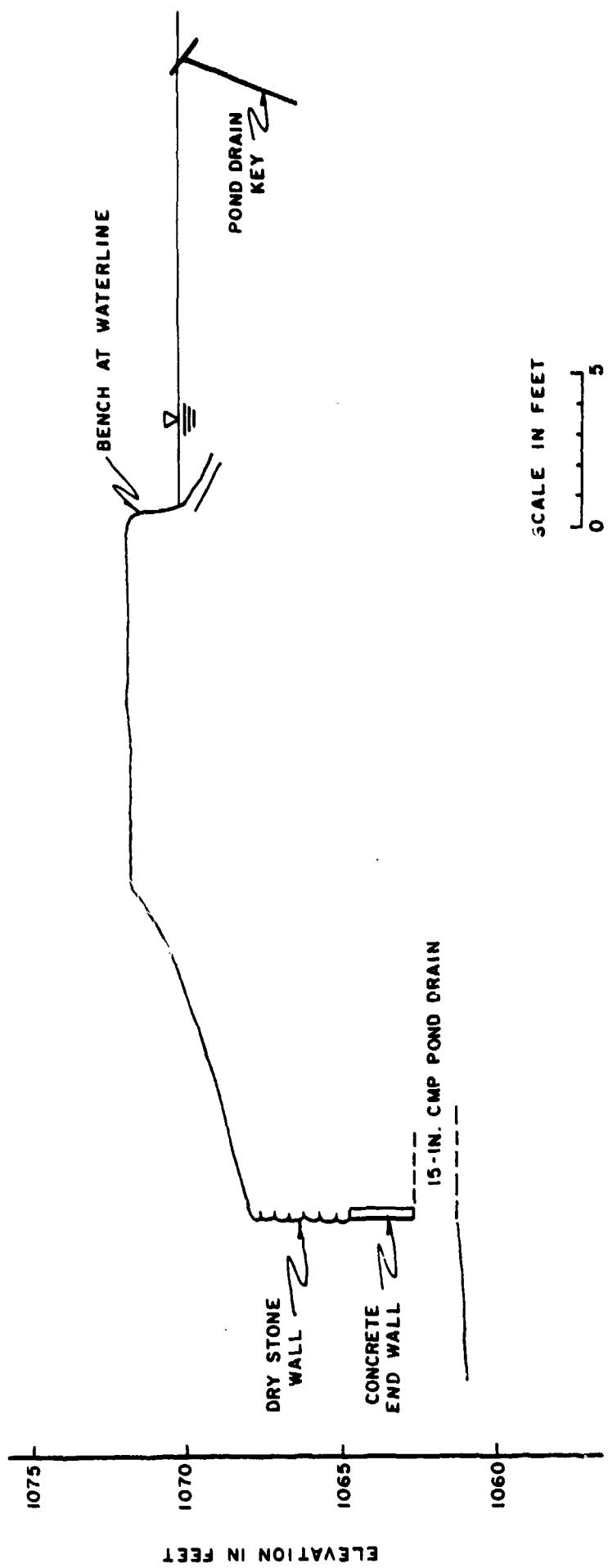
PLATE 2



SPILLWAY ELEVATION ASSUMED AT 1070.0
 ALL OTHER ELEVATIONS RELATIVE
 DATA OBTAINED DURING VISUAL INSPECTION
 ON 4/27/81

PROFILE ALONG CREST
 LOWER RICKARDS DAM

PLATE 3



DRAWN FROM DATA OBTAINED DURING
VISUAL INSPECTION ON 4/27/81

MAXIMUM SECTION AT POND DRAIN
LOWER RICKARDS DAM

PLATE 4

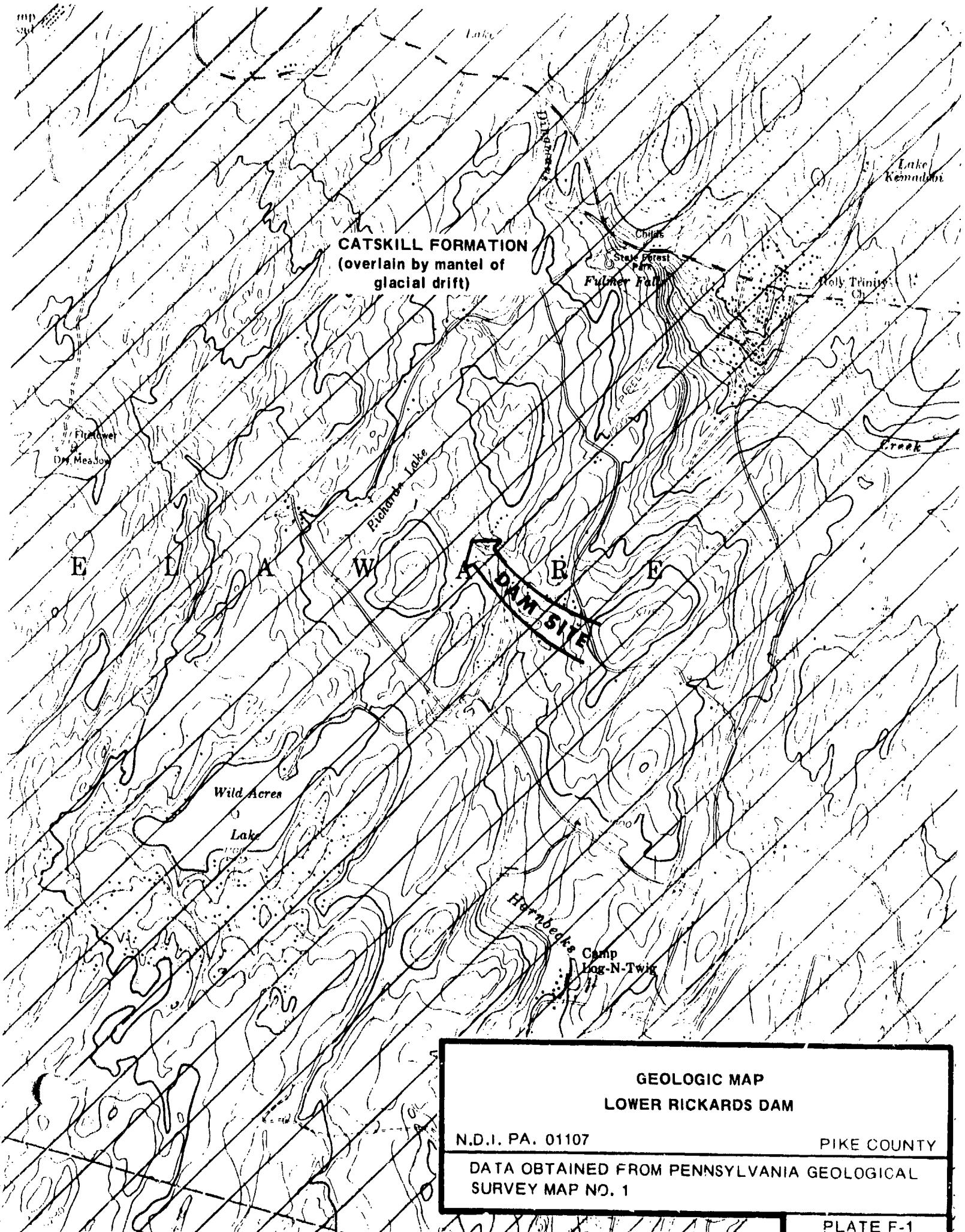
APPENDIX

F

LOWER RICKARDS LAKE DAM SITE GEOLOGY

Lower Rickards Lake Dam is located in the Glaciated Low Plateaus section of the Appalachian Plateaus physiographic province. As shown in Plate F-1, the dam site and much of the surrounding areas are underlain by a partial mantle of glacial drift deposits of Pleistocene age. These deposits consist of varying amounts of boulders, gravel, sand, silt and clay. Numerous sandstone boulders were observed downstream of the dam toe during the field inspection. The bedrock consists of gray fine-grained sandstone of the Upper Devonian age Catskill Formation. Bedrock is well exposed upstream of the right abutment area, indicating relatively shallow soil conditions. Here, bedding strikes east-northeast having a northerly (upstream) dip of 10 degrees. High angle jointing strikes north-northeast and nearly east-west.

No water seepage was observed during the field inspection. This may in part be due to the favorable upstream direction of bedrock dip. It was also noted that the dam invert may be located within the limits of the original stream channel. Although infilled stream channels are commonly an area of seepage, there was none detected.



**GEOLOGIC MAP
LOWER RICKARDS DAM**

N.D.I. PA. 01107

PIKE COUNTY

DATA OBTAINED FROM PENNSYLVANIA GEOLOGICAL
SURVEY MAP NO. 1

PLATE F-1